Comprehensive Fisheries Survey Report of Geneva Lake – Walworth County 2015

Geneva Lake from Chapin Road (photo credit: Ted Peters, Geneva Lake Environmental Agency).

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EXECUTIVE SUMMARY

A comprehensive fisheries survey was conducted on Geneva Lake in Walworth County during the spring and fall of 2015. The primary goal of the survey was to assess gamefish and panfish population abundance, size structure and growth. The survey began on April 6th, concluded on December 10th and included various netting and electrofishing assessments. Species captured included walleye, muskellunge, largemouth bass, smallmouth bass, bluegill, yellow perch and lake trout. Similar surveys were conducted in 2009 and serve as a comparison for the results of this report.

Walleye abundance, at 0.59 per acre, was relatively low, but higher than many other lakes in the area. Nearly 81% of the walleye captured were over the 15" minimum length limit. The Geneva Lake walleye population has a long history of being dominated by very large individuals, with very few fish in smaller size classes. Size structure during the 2015 survey was much more balanced than the 2009 survey, with a high number of fish in the 14-16" size class. Relative abundance was also much higher during the 2015 survey than in 2009. Low abundance and very strong size structure is fairly typical for other nearby lakes which have a limited stocking history and a high proportion of harvest of legal walleye. Walleye growth rates in Geneva Lake were above the accelerated growth typically seen in southern Wisconsin, with many fish reaching the 15" minimum length limit at age two, prior to spawning for the first time. The lake has a recent history of supporting low levels of walleye natural reproduction. In the 2015 survey, 40% of the yearling walleye captured during spring netting were naturally reproduced. Walleye natural reproduction in Geneva Lake is primarily limited by low adult abundance. The Walworth County Chapter of Walleyes for Tomorrow has been operating a mobile walleye fry hatchery on Geneva Lake since 2012, releasing a total of 18.4 million fry into the lake during five years of operation. The remaining 60% of yearling walleye sampled during the 2015 fyke netting survey were produced and stocked by Walleyes for Tomorrow's mobile hatchery in 2014. The Wisconsin Department of Natural Resources stocked Geneva Lake with over 108,000 large fingerling walleye in fall of 2015, which should create a strong year class of spawning adult fish in three to five years. Protecting walleye for at least one spawning season through restrictive harvest regulations would improve the abundance of large adult walleye, contribute to improved natural reproduction and help maintain a long term, fishable walleye population in Geneva Lake.

Alternate year **muskellunge** stocking began in 2010 and the species has quickly become a fixture of the Geneva Lake fish community. Muskellunge relative abundance was 0.4 per net night, which matches the expected catch rate for A1 musky waters. Size structure was indicative of a developing fishery ($PSD_{38/30}$ 11), though several individuals were nearing the 40" minimum length limit. Musky growth rates in Geneva Lake were very accelerated, with the 2010 and 2012 stocking classes outpacing statewide average growth rates by several inches. Musky provide important top predator pressure in Geneva Lake and a popular new fishing option. Stocking events will continue in the future, possibly on an annual basis. Moving to a 50" minimum length limit would maximize the benefits of the musky stocking program, given accelerated growth rates and the trophy potential of the population.

Largemouth bass relative abundance was slightly below average (15.3 per mile), though size structure was very strong (PSD 69). Over 37% of the bass captured during the survey were greater than the 14" minimum length limit. Relative abundance was equal to the 2009 survey, though size structure was much stronger in 2009, primarily due to a higher number of small fish captured during the 2015 survey. Late spring electrofishing surveys on Geneva Lake are hampered by the high number of private piers on the lake, which limits access to the nearshore sampling zone and likely depresses catch rates. Geneva Lake has a long history of providing a popular bass fishery with very good size structure. Geneva Lake hosts several bass fishing tournaments each year, which offer some additional information on catch rates

through time. Bass tournament catch rates have fluctuated quite a bit since 2008, with largemouth bass generally outnumbering smallmouth bass two-to-one. May has traditionally been the most successful month for smallmouth bass tournament catch rates, whereas largemouth bass are caught at the highest rate in July and August. **Smallmouth bass** are also abundant in Geneva Lake and are a highly desirable gamefish for many anglers, but were not sampled effectively during the 2015 and 2009 surveys.

Bluegill relative abundance was low at 30.7 per mile. Size structure was also very limited, with an average size of 4.7" and only 11% of bluegill larger than 6". Bluegill were not effectively sampled during the 2009 survey. **Yellow perch** relative abundance was also low at 23.3 per mile. Average size was 5.4" and only 20% of perch were over 6". Perch relative abundance and size structure were generally higher in the 2009 survey. Panfish relative abundance was also likely hampered by the high number of piers during the lake spring electrofishing survey runs.

Lake trout were captured during a targeted fall fyke netting survey, with a relative abundance of 7.9 per net night. Size structure was very strong, with an average size of 27.5" and a PSD of 100. All 85 fish that were measured during the survey were larger than the 17" minimum length limit. Lake trout are stocked annually in Geneva Lake and provide a unique and relatively popular fishing opportunity. Geneva lake trout size structure and relative abundance are roughly equal to other popular Wisconsin trout fisheries in Trout Lake (Vilas County) and Big Green Lake (Green Lake County).

DNR Science Services staff completed multiple **cisco** surveys on Geneva Lake in 2013 and 2015, including two gill netting surveys and an evening hydro acoustic survey. Geneva Lake is one of very few lakes in Wisconsin capable of supporting a high-density cisco population, which are an important, high-energy forage option for popular gamefish species. Science Services surveys indicate that Geneva Lake hosts an extremely high density of cisco (up to 187.3 per net night) and that the population is primarily composed of smaller, younger fish.

METHODS

A comprehensive fisheries survey was conducted on Geneva Lake in Walworth County during the spring and fall of 2015. The primary goal of the survey was to assess gamefish and panfish population abundance, size structure and/or growth. Up to 14 fyke nets were fished to capture walleye and muskellunge on Geneva Lake from April 6th through April 20th for a total of 139 net nights. Due to a relatively late ice-out date, nets were not set in traditional northern pike sampling locations, as the bulk of the pike spawning season was presumed to have passed. As such, northern pike data is included in the "Other Species" section of this report. Early spring electrofishing targeted walleye and was conducted from April 21st through April 23rd for a total of 15.0 miles. Late spring electrofishing targeted largemouth bass, smallmouth bass and panfish and was conducted from May 12th through June 4th for a total of 10.0 miles. An additional fall fyke netting effort targeted lake trout and walleye and was conducted from November 2nd through November 5th for a total of 18 net nights. Fall electrofishing targeted walleye and was conducted on December 9th and 10th for a total of 7.0 miles. Figure 1 displays the 2015 netting and electrofishing sampling locations and Table 1 summarizes the effort and target species for each survey type.

Figure 1. Map of fyke netting sites (○) during the 2015 Geneva Lake survey. Electrofishing covered the large majority of the available shoreline.

Table 1. Summary of survey types, effort and target species during the 2015 Geneva Lake survey.

Survey Type	Dates	Total Effort	Target Species
Spring Netting I	April 6th – April 20th	139 net nights	Walleye/Muskellunge
Spring Electrofishing I	April 21st – April 23rd	15.0 miles	Walleye
Spring Electrofishing II	May 12th – June 4th	10.0 miles	Bass and Panfish
Fall Netting	November 2nd – November 5th	18 net nights	Lake Trout/Walleye
Fall Electrofishing	December 9th – December 10th	7.0 miles	Walleye

During the survey, a subsample of gamefish and panfish was measured to the nearest tenth-inch. A subsample of gamefish was also weighed to the nearest tenth-pound. Mean length, maximum length and catch per unit effort (e.g., catch per net night or catch per electrofishing mile) were calculated for all species sampled. Walleye and muskellunge were also given differential finclips to identify recaptures and/or facilitate abundance estimates (female – right pectoral, male – left pectoral, unknown or immature – top caudal). The walleye population estimate was calculated using the Chapman modification of the Petersen index:

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

where M is the number of marked fish at large, C is the number of fish examined for marks during the recapture run, and R is the number of marked fish captured during the recapture run. Aging structures collected from walleye allowed for estimation of growth rates.

RESULTS

Walleye

Walleye were targeted and captured during the early spring fyke netting survey from April 6th through April 20th. A total of 934 walleye were captured during netting, for a moderate catch rate of 6.7 per net night (Table 2). Females greatly outnumbered males 649 to 252 (2.6:1) and female average length was greater by nine inches. The largest walleye of the fyke netting survey were a 30.0", 14.2 pound female and a 30.5", 13.5 pound female (Figure 3). Walleye proportional stock density (PSD, proportion of walleye at least 10" that were also at least 15") was 83, indicating a population primarily composed of larger fish. Of the fish captured, 80.9% were of legal size (15" and greater), including all of the female walleye. Walleye greater than 10" were given differential finclips (female – right pectoral, male – left pectoral, unknown or immature – top caudal) to identify recaptures and facilitate an abundance estimate following recapture electrofishing sampling. Fifteen yearling walleye, ranging in size from 8.3 – 10.4", were also captured during the fyke netting survey. Tissue samples from these fish were submitted to the Molecular Conservation Genetics Laboratory at UW-Stevens Point. Genetic analysis indicated nine of the fish (60%) were the product of the 2014 Walleyes for Tomorrow fry stocking and six (40%) were naturally produced. Tissue samples from a total of 62 juvenile walleye, ranging in size from 13.9 – 15.4" were also submitted to the lab, where genetic analysis indicated they were the product of either DNR stocking or natural reproduction.

Figure 2. Fisheries Technicians Josh Krall and Sean Merley with a pair of 13 pound Geneva Lake walleye.

Table 2. Walleye spring fyke netting catch statistics during the 2015 Geneva Lake survey (139 net nights).

	Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	Mean Weight (Pounds)	PSD	% Legal
Total	934	394	6.7	21.4	30.5	4.9	83	80.9
Female	649	280	4.7	24.3	30.5	6.9	-	100.0
Male	252	95	1.8	15.2	21.6	1.4	-	38.9
Unknown	33	23	0.2	11.4	15.9	0.79	-	21.7

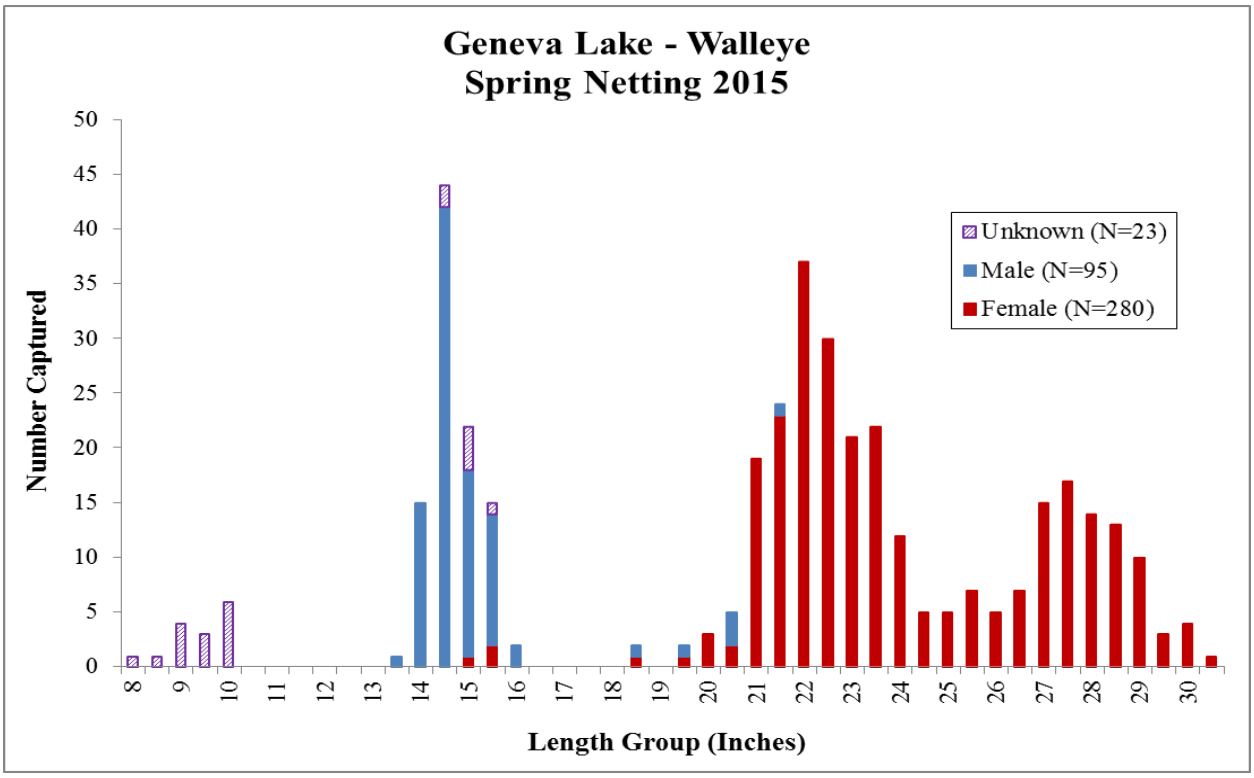

Figure 3. Sex-specific length frequency for walleye captured during spring fyke netting on Geneva Lake in 2015.

Walleye were also targeted and captured during the early spring electrofishing survey conducted April 21st through April 23rd. A total of 157 walleye (156 adults) were captured during electrofishing, for a relatively low catch rate of 10.5 per mile. All walleye captured during the electrofishing runs were inspected for existing finclips to facilitate an abundance estimate. A walleye population estimate was calculated using the Chapman modification of the Petersen index:

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

where M is the number of marked fish at large, C is the number of fish examined for marks during the recapture run, and R is the number of marked fish captured during the recapture run. The 2015 Geneva Lake walleye population estimate was calculated as:

$$N = \frac{(829+1)(156+1)}{(41+1)} - 1$$

where N = 3,102 or 0.59 per lake acre, 95% CI [2,416, 4,133].

A subsample of all captured walleye was also weighed to the nearest tenth-pound and dorsal spines were collected to estimate growth rates. Age estimation allowed for comparison to average walleye growth rates in southern Wisconsin (Figure 4), which indicated Geneva walleye outpace average growth rates at nearly every age. The sample size of mid-size walleye was insufficient to produce a catch curve for

estimation of survival, mortality and exploitation.

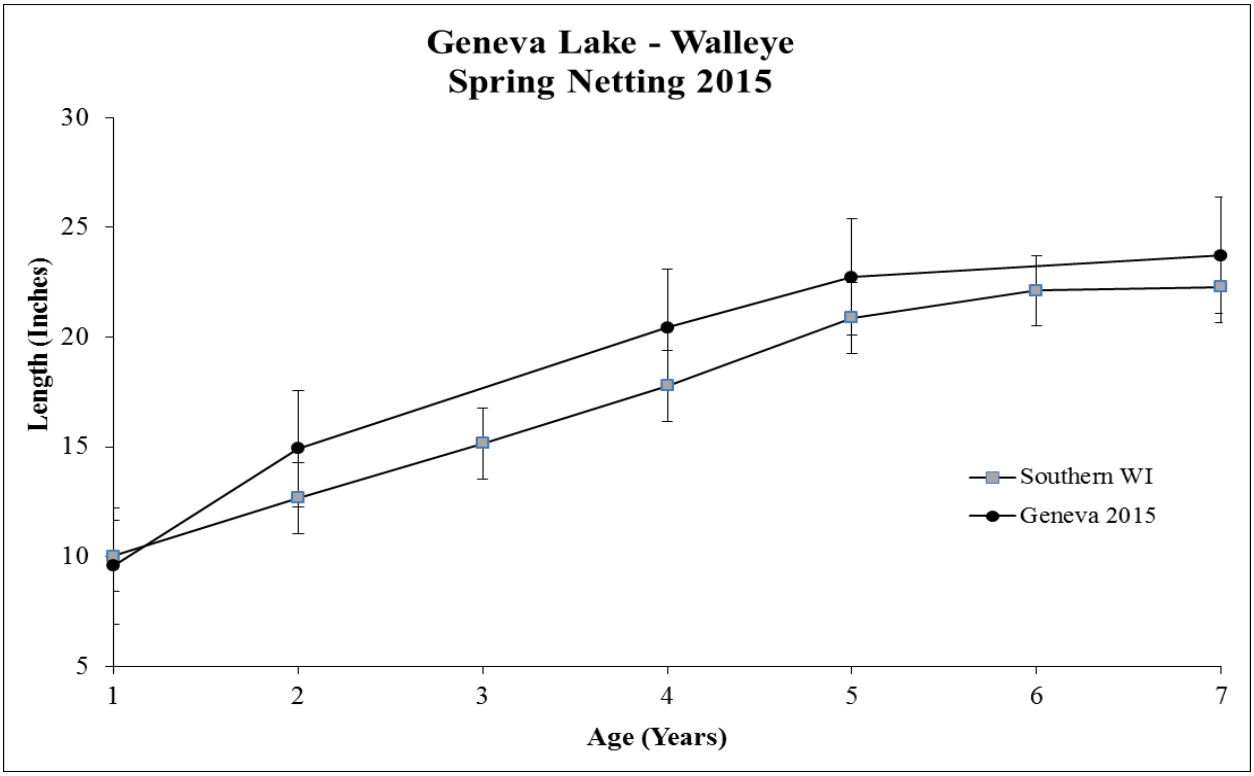

Figure 4. Length at age estimate for walleye captured during spring fyke netting on Geneva Lake in 2015.

Walleye were also captured during an additional fall fyke netting survey from November 2nd through November 5th. A total of four walleye were captured during fall fyke netting, for a low catch rate of 0.2 per net night (Table 3). The fish ranged in size from 7.4 – 11.0" and were primarily captured at the locations used for large fingerling stocking in September and October.

Figure 5. Multiple year classes of walleye captured during the fall survey on Geneva Lake.

Walleye were also captured during a fall electrofishing survey primarily targeting young-of-year (YOY) walleye on December 9th and 10th. A total of 87 YOY walleye were captured during electrofishing, for a relatively low catch rate of 11.9 per mile (Table 4).

Table 3. Walleye fall fyke netting catch statistics during the 2015 Geneva Lake survey (18 net nights).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
4	4	0.2	8.5	11.0

The walleye ranged in size from 6.3 – 9.6" (Figure 6) and were primarily captured at the locations used

for large fingerling stocking in September and October. Genetic analysis at the Molecular Conservation Genetics Laboratory at UW-Stevens Point determined that all of the 87 YOY walleye captured during the two fall surveys were stocked large fingerlings.

Table 4. Walleye fall electrofishing catch statistics during the 2015 Geneva Lake survey (7.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
87	87	12.4	7.6	9.6

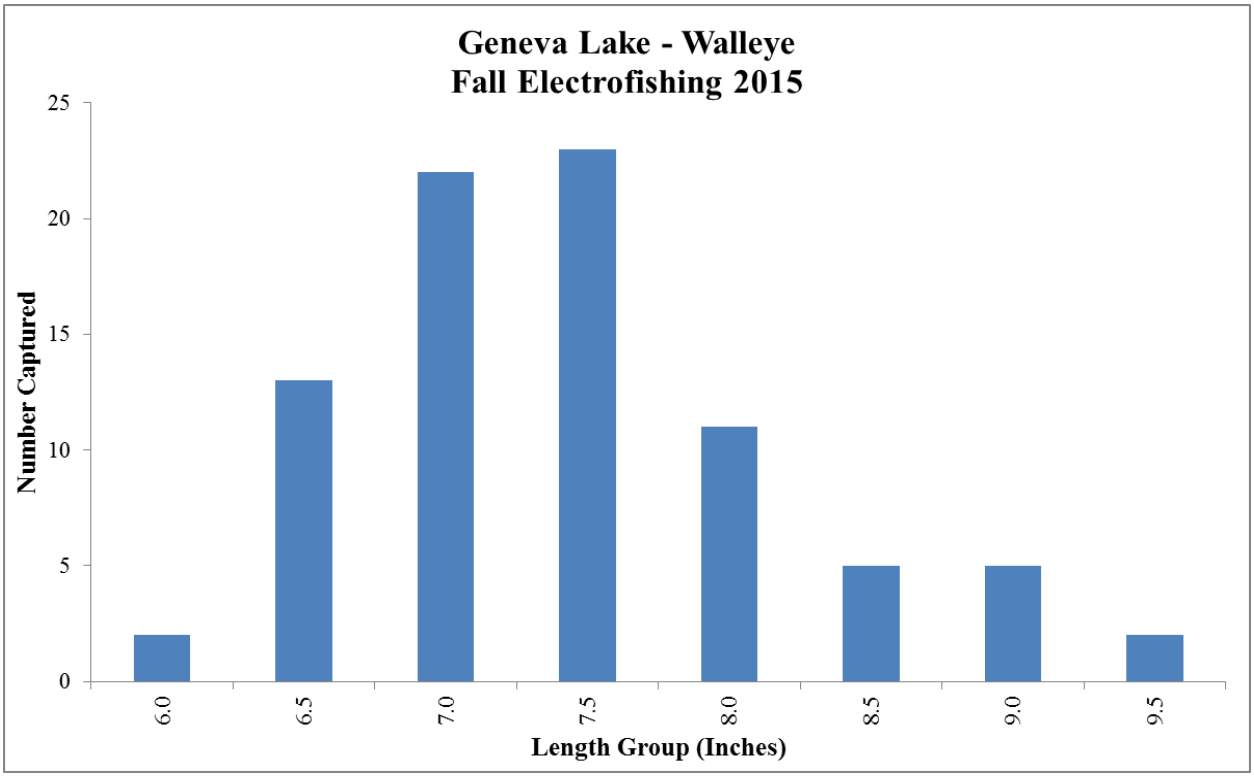

Figure 6. Length frequency for walleye captured during fall electrofishing on Geneva Lake in 2015 (N=87).

Walleye were also captured during the late spring electrofishing survey targeting bass and panfish (Table 5). These results are considered bycatch and are not included in the analyses shown above.

Table 5. Walleye late spring electrofishing bycatch statistics during the 2015 Geneva Lake survey (10.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
7	7	0.7	19.0	23.8

Muskellunge

Muskellunge were targeted and captured during the early spring fyke netting survey from April 6th through April 20th. A total of 58 muskies were captured during fyke netting, for a moderate catch rate of 0.4 per net night (Table 6). Males outnumbered females 25 to 3 (8.3:1), though several large fish of unknown sex were captured and were likely female. The largest muskellunge of the fyke netting survey was a 39.0" fish of unknown sex (Figure 8). Musky $PSD_{38/30}$ (proportion of muskellunge at least 30" that were also at least 38") was 11, indicating a developing fishery primarily composed of young adult fish. Of the fish captured, none were of legal size (40" and greater).

Figure 7. A 42.5", 23lb muskellunge caught on Geneva Lake in fall of 2016 (photo credit: Steve Everetts).

Table 6. Muskellunge spring fyke netting catch statistics during the 2015 Geneva Lake survey (139 net nights).

	Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	PSD	% Legal
Total	58	56	0.4	36.6	39.0	11	0.0
Female	3	3	<0.1	36.6	37.0	-	0.0
Male	26	25	0.2	32.2	38.0	-	0.0
Unknown	29	28	0.2	35.2	39.0	-	0.0

All muskellunge stocked into Geneva Lake were marked with a differential fin removal prior to stocking to allow for identification of year classes and comparison of growth rates to statewide average (Figure 9). Muskellunge growth in Geneva Lake outpaced statewide average by several inches among age 3 and age 5 fish. The muskellunge sample size was insufficient to produce a catch curve for estimation of survival, mortality and exploitation.

Muskellunge were also captured during other portions of the survey targeting other species (Tables 7, 8 and 9). These results are considered bycatch and are not included in the analyses shown here.

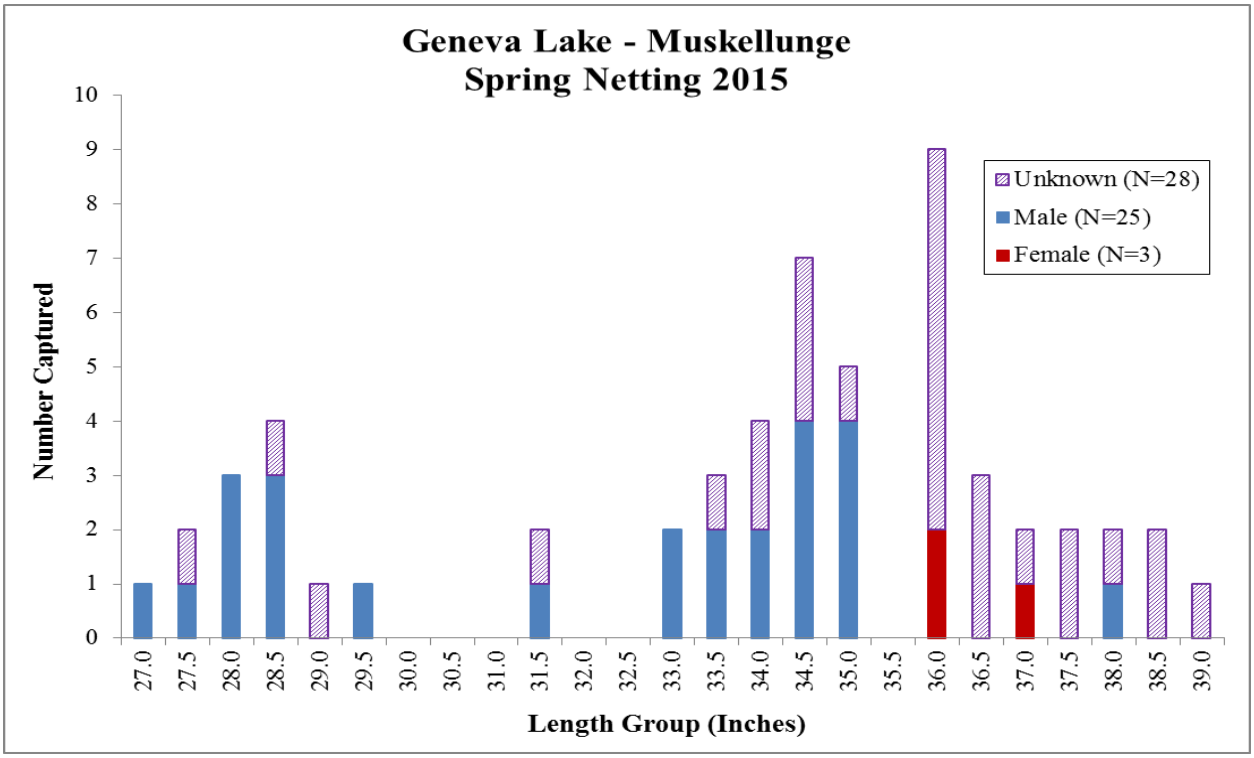

Figure 8. Sex-specific length frequency for muskellunge captured during spring fyke netting on Geneva Lake in 2015.

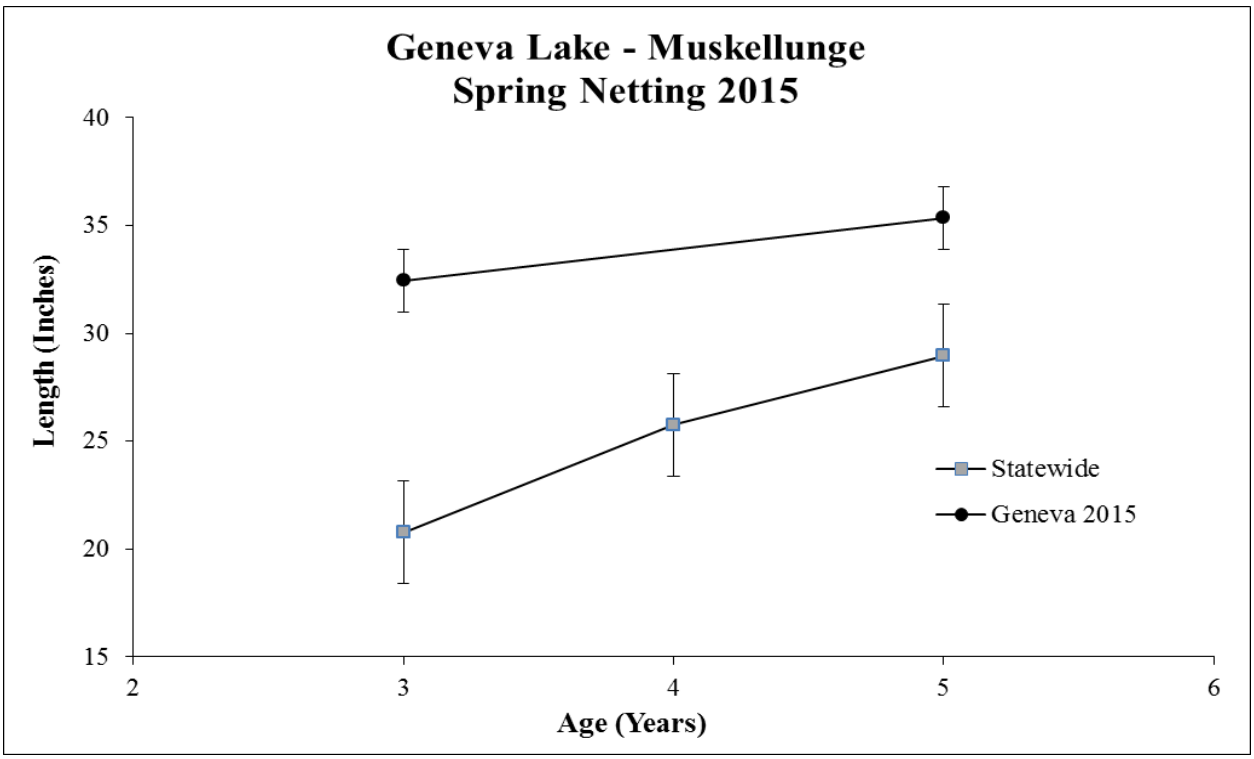

Figure 9. Length at age estimate for muskellunge captured during spring fyke netting on Geneva Lake in 2015.

Table 7. Muskellunge early spring electrofishing bycatch statistics during the 2015 Geneva Lake survey (15.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
2	2	0.1	34.0	36.5

Table 8. Muskellunge late spring electrofishing bycatch statistics during the 2015 Geneva Lake survey (10.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
2	2	0.2	32.5	33.2

Table 9. Muskellunge fall electrofishing bycatch statistics during the 2015 Geneva Lake survey (7.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
1	1	0.1	-	20.9

Largemouth Bass

Largemouth bass were targeted and captured during the late spring electrofishing survey from May 12th through June 4th. A total of 153 largemouth bass were captured during electrofishing, for a moderate catch rate of 15.3 per mile (Table 10). The largest bass of the survey was 21.5" (Figure 11). Largemouth bass PSD (proportion of bass at least 8" that were also at least 12") was 69, indicating a population primarily composed of large fish. Of the fish captured, 37.3% were of legal size (14" and greater).

Figure 10. Fisheries Technician Sean Merley with a big Geneva Lake largemouth bass.

Largemouth bass were also captured during the spring fyke netting survey (Table 11). These results are considered bycatch and are not included in the analyses shown above.

Largemouth bass have been a popular target species for fishing tournaments on Geneva Lake for several years. Tournament results since 2008 have shown widely fluctuating catch rates, with the highest smallmouth bass catch rates in May and the highest largemouth bass catch rates in July and August (Figure 12). On average, largemouth bass are captured twice as often as smallmouth bass during tournaments on Geneva Lake.

Table 10. Largemouth bass late spring electrofishing catch statistics during the 2015 Geneva Lake survey (10.0 miles).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	PSD	% Legal
153	153	15.3	13.5	21.5	69	37.3

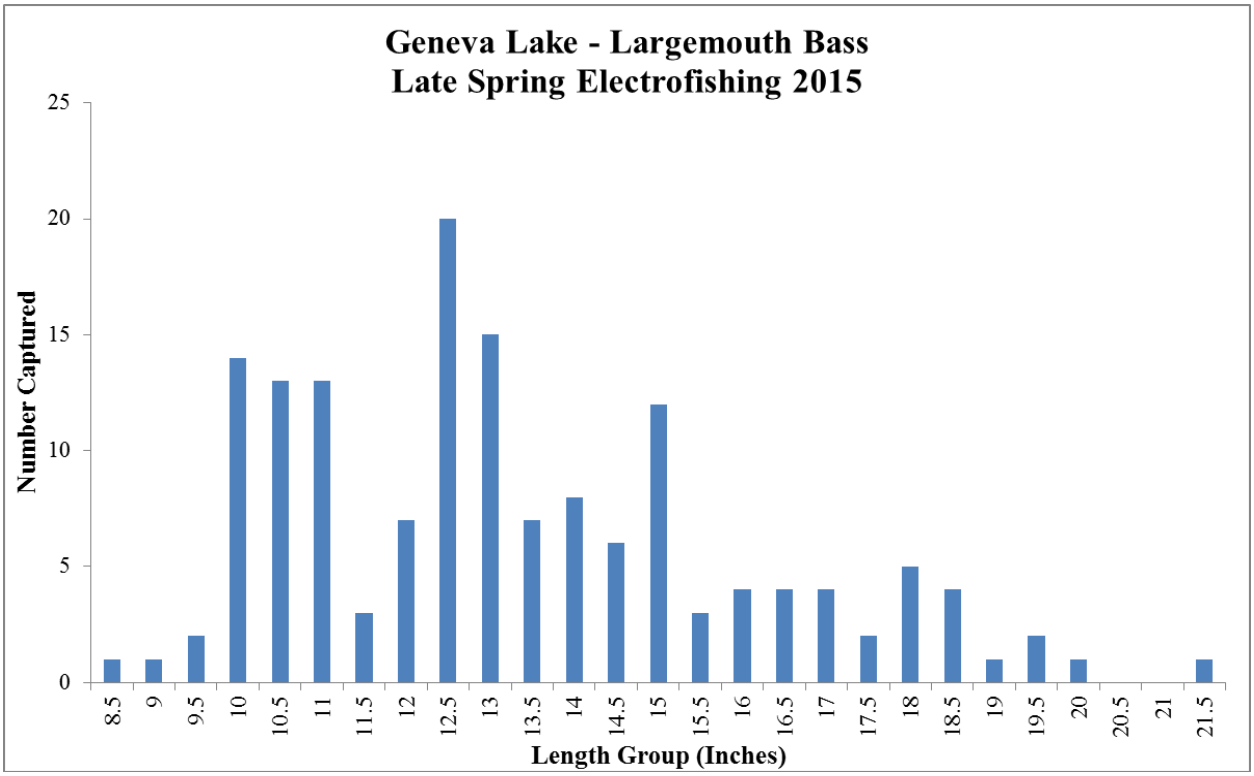

Figure 11. Length frequency for largemouth bass captured during late spring electrofishing on Geneva Lake in 2015 (N=153).

Table 11. Largemouth bass spring fyke netting bycatch statistics during the 2015 Geneva Lake survey (139 net nights).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
69	10	0.5	16.1	20.3

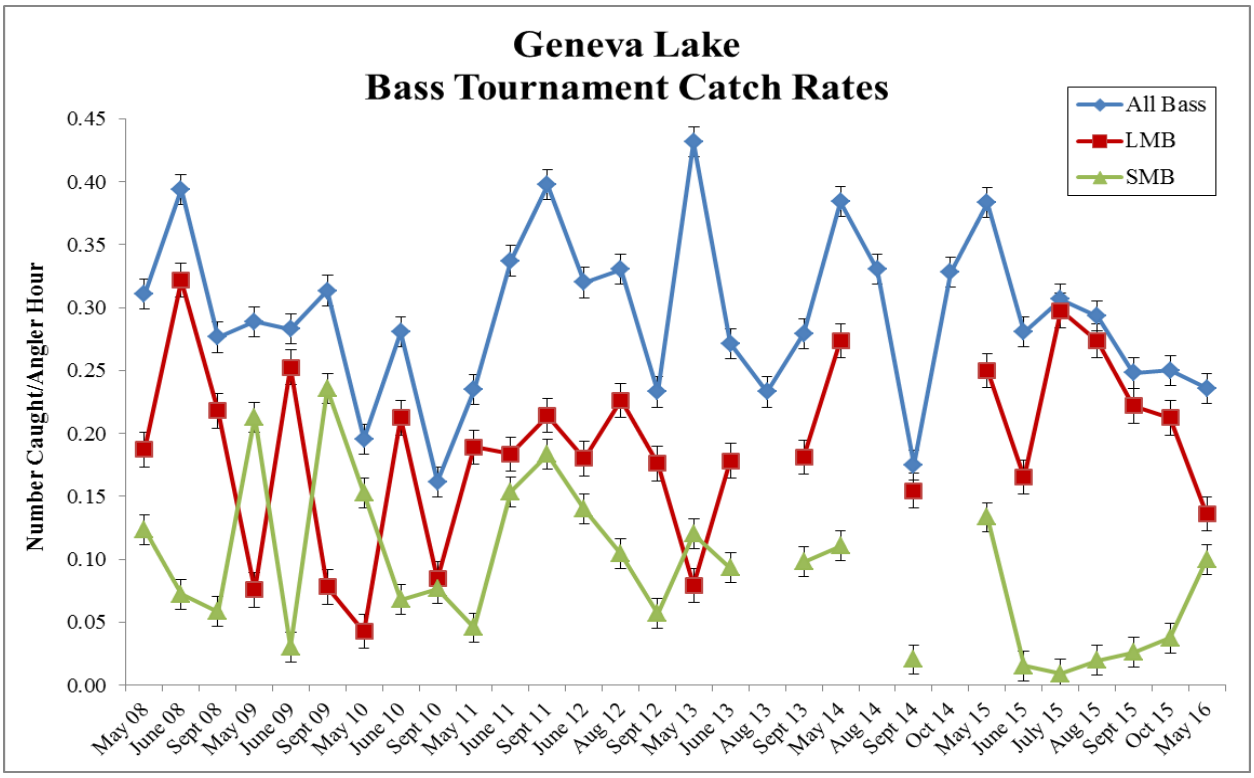

Figure 12. Bass fishing tournament results from Geneva Lake (2008-2015). Average catch rate for each species is indicated by the dotted lines.

Bluegill

Bluegill were targeted and captured during the "catch all" portion of the late spring electrofishing survey from May 12th through June 4th. A total of 46 bluegill were captured during electrofishing, for a low catch rate of 30.7 per mile (Table 12). The largest bluegill was 7.3" (Figure 13). Average size was 4.7" and sample size was not sufficient to calculate PSD. Of the fish captured, only 10.9% were 6" and greater.

Table 12. Bluegill late spring electrofishing catch statistics during the 2015 Geneva Lake survey (1.5 miles). Sample size was not sufficient to calculate PSD.

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	PSD	% 6"+
46	46	30.7	4.7	7.3	N/A	10.9

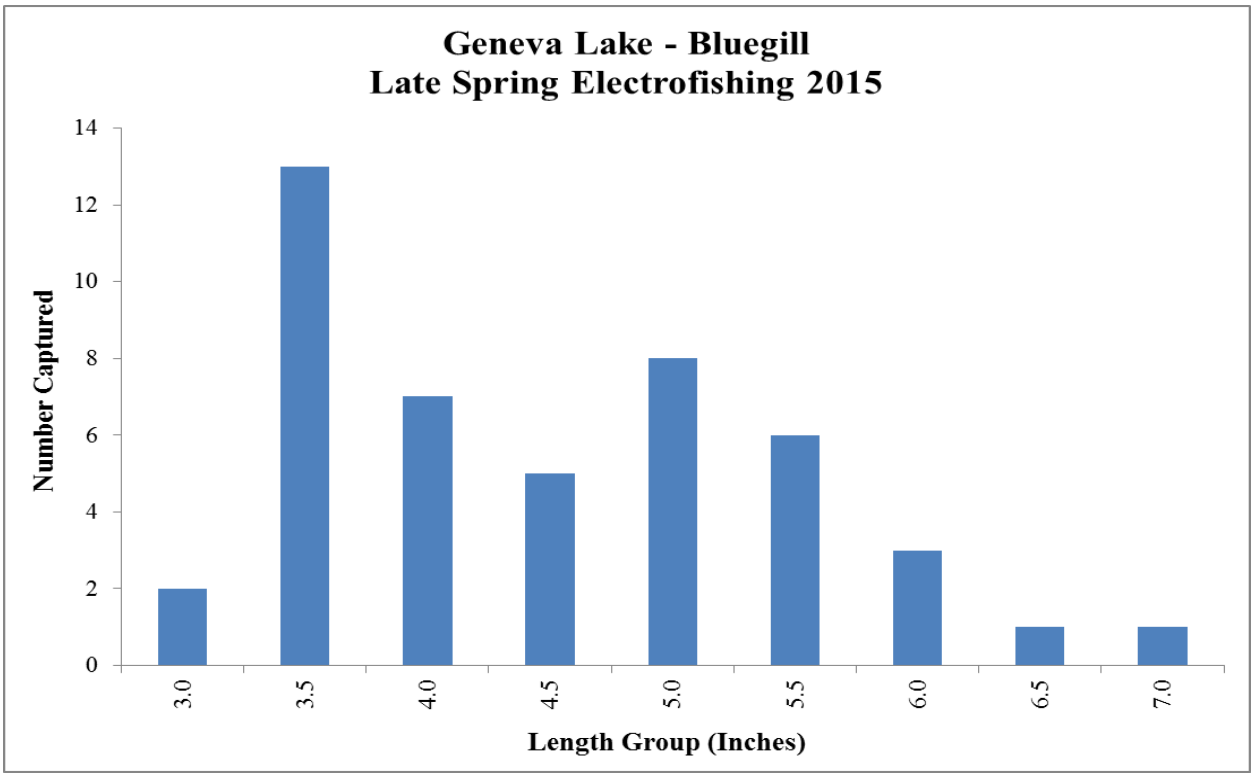

Figure 13. Length frequency for bluegill captured during late spring electrofishing on Geneva Lake in 2015 (N=46).

Yellow Perch

Yellow perch were targeted and captured during the "catch all" portion of the late spring electrofishing survey from May 12th through June 4th. A total of 35 yellow perch were captured during electrofishing, for a low catch rate of 23.3 per mile (Table 13). The largest perch was 9.4" (Figure 15). Average size was 5.4" and sample size was not sufficient to calculate PSD. Of the fish captured, 20.0% were 6" and greater.

Figure 14. Fisheries Biologist Luke Roffler with two handfuls of Geneva Lake yellow perch.

Table 13. Yellow perch late spring electrofishing catch statistics during the 2015 Geneva Lake survey (1.5 miles). Sample size was not sufficient to calculate PSD.

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	PSD	% 6"+
35	35	23.3	5.4	9.4	N/A	20.0

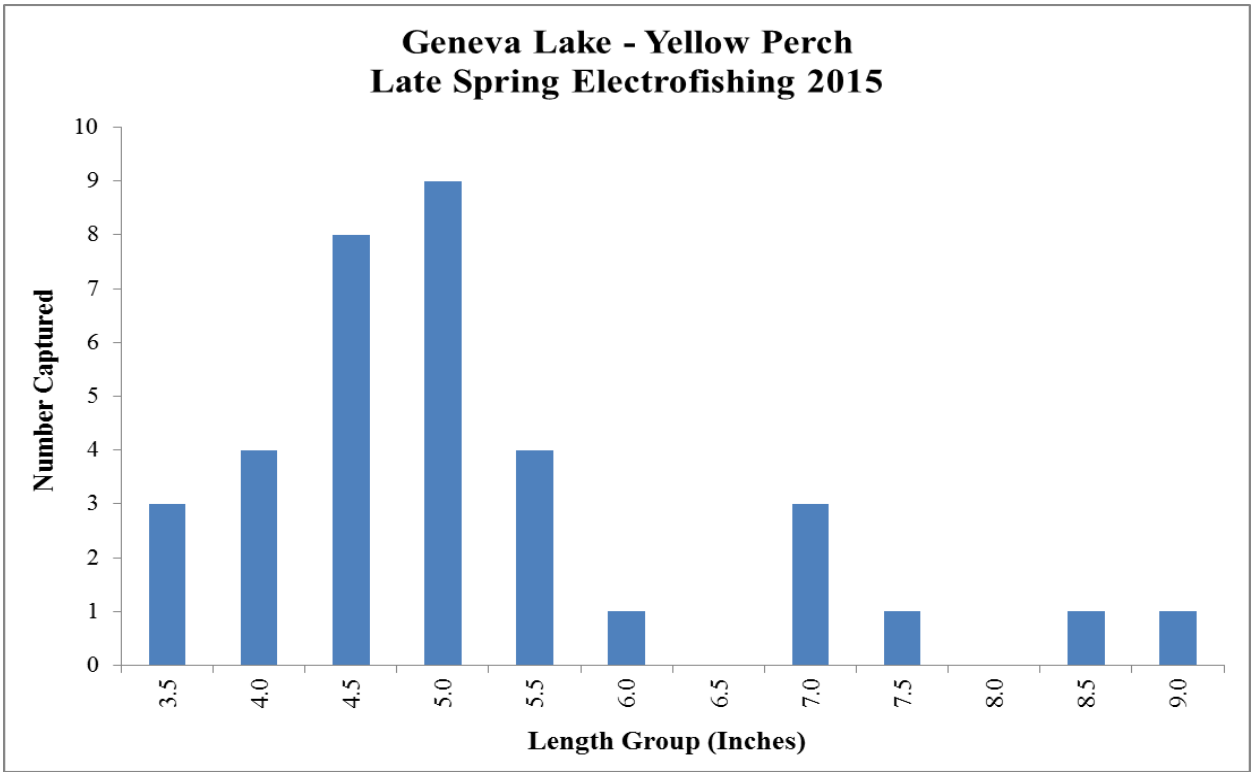

Figure 15. Length frequency for yellow perch captured during late spring electrofishing on Geneva Lake in 2015 (N=35).

Lake Trout

Lake trout were targeted and captured during an additional fall fyke netting survey from November 2nd through November 5th. A total of 142 lake trout were captured during netting, for a catch rate of 7.9 per net night (Table 14). The largest lake trout was a 33.2" fish of unknown sex (Figure 17). Lake trout PSD (proportion of lake trout at least 12" that were also at least 20") was 100, indicating a population primarily composed of large fish. Of the fish captured, all were of legal size (17" and greater).

Figure 16. Fisheries Technician Josh Krall with a Geneva Lake lake trout captured in the fall of 2015.

Table 14. Lake trout fall fyke netting catch statistics during the 2015 Geneva Lake survey (18 net nights).

	Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)	PSD	% Legal
Total	142	140	7.9	27.5	33.2	100	100.0
Female	16	16	0.9	27.6	29.0	-	100.0
Male	39	39	2.2	27.0	33.0	-	100.0
Unknown	87	85	4.8	27.7	33.2	-	100.0

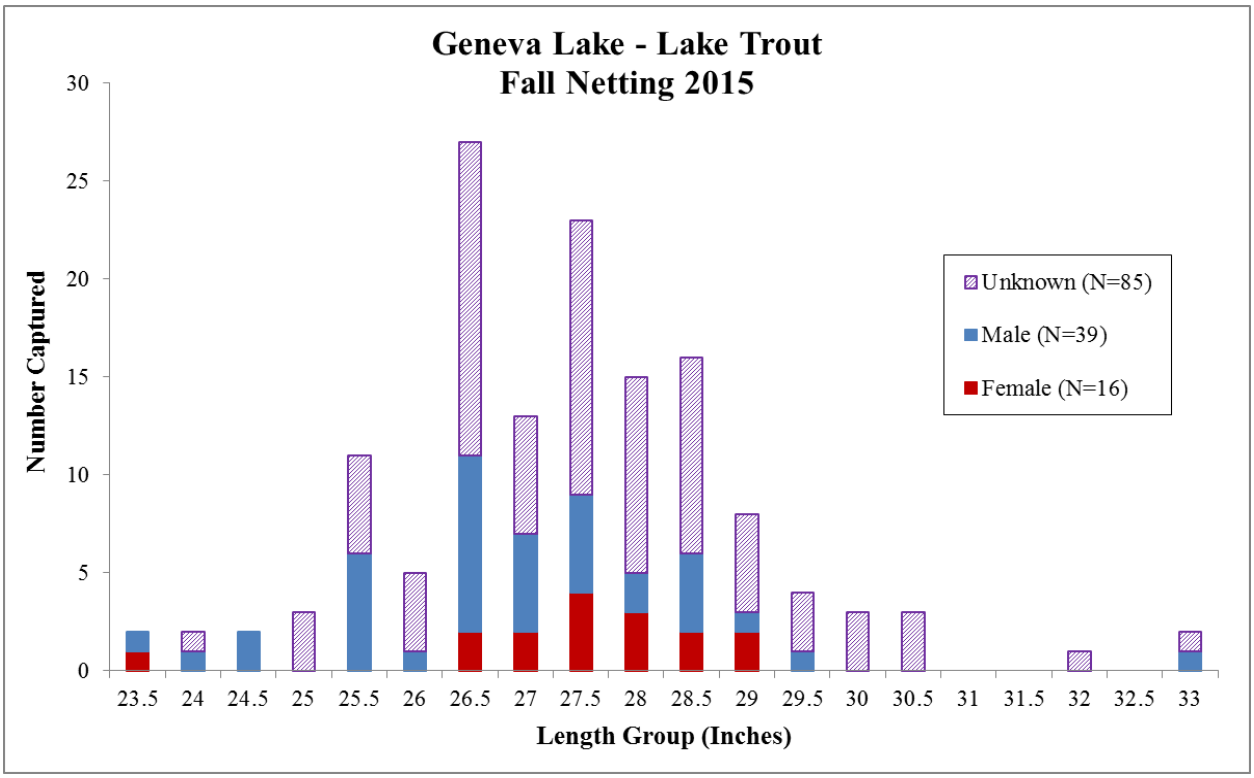

Figure 17. Sex-specific length frequency for lake trout captured during fall fyke netting on Geneva Lake in 2015.

A single lake trout was also captured during the spring fyke netting survey (Table 15). These results are considered bycatch and are not included in the analyses shown above.

Table 15. Lake trout spring fyke netting bycatch statistics during the 2015 Geneva Lake survey (139 net nights).

Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
1	-	<0.1	-	-

Other Species

Figure 18. Young-of-year walleye and multiple year classes of cisco captured during the fall of 2015.

By far, the most important non-game fish species in Geneva Lake is cisco, a high fat, high energy forage species unique to deep-water lakes. Targeted cisco monitoring surveys have been completed by DNR Science Services staff on several deep-water lakes in Wisconsin, including Geneva Lake. Recent gill net and hydro acoustic surveys have indicated a very high abundance of cisco in Geneva Lake. The 2015 gill netting catch rate of 187.3 per net night was nearly four times higher than Big Green Lake in Green Lake County and nearly six times higher than the Chain O' Lakes in Waupaca County (Lyons et al. 2015; P. Kanehl, Wisconsin Department of Natural Resources, unpublished data). The 2015 hydro acoustic survey of Geneva Lake produced a one of the highest density estimates in Wisconsin (T. Parks, Wisconsin Department of Natural Resources, unpublished data).

Several other fish species were captured during the comprehensive survey on Geneva Lake in 2015. Bycatch summary results are shown in Tables 16-17. Not all species encountered during the survey were recorded.

Table 16. "Other species" spring fyke netting bycatch summary during the 2015 Geneva Lake survey (139 net nights).

Species	Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
Northern Pike	72	16	0.5	26.9	34.0
Smallmouth Bass	16	1	0.1	-	19.2

Table 17. "Other species" late spring electrofishing bycatch summary during the 2015 Geneva Lake survey (10.0 miles for gamefish, 1.5 miles for others).

Species	Number Captured	Number Measured	CPUE	Mean Length (Inches)	Max Length (Inches)
Black Crappie	2	2	1.3	11.1	11.4
Bowfin	6	-	4.0	-	-
Brown Bullhead	2	-	1.3	-	-
Brown Trout	2	2	0.2	11.6	15.0
Pumpkinseed	8	8	5.3	6.1	9.1
Rock Bass	32	32	21.3	6.7	10.3
Smallmouth Bass	19	19	1.9	12.8	16.6

DISCUSSION

Geneva Lake, at 5,204 acres, provides anglers with a diverse and popular mix of gamefish, including walleye, muskellunge, northern pike, largemouth bass, smallmouth bass, lake trout and several species of panfish. The lake is unique in its bathymetry, containing a high quantity of deep-water habitat (up to 135' deep), rocky slopes, deep weed lines, and some shallow flats consisting of sand and gravel substrate. The Geneva Lake watershed is also home to various sizable tributaries, some of which offer riparian wetland habitat and/or coldwater refugia for gamefish, as well as prime habitat for trout and other coldwater specialist species. Geneva Lake contains a remarkable quantity and diversity of unique forage species, including mimic shiners and cisco. Geneva Lake's size, habitat variety and forage availability is reflected in the accelerated growth rates of multiple gamefish species and the fantastic fishing opportunities anglers enjoy.

The driving force behind the above average gamefish growth rates in Geneva Lake is the very high-density **cisco** population present in the system. The presence of cisco in a fish community greatly increases the growth potential of popular gamefish (walleye, muskellunge, lake trout, etc.). The depth and dissolved oxygen profiles of the lake provide a high amount of suitable cisco habitat. Various surveys conducted by DNR Science Services staff in recent years have indicated Geneva Lake supports a very high-density cisco population with gill netting catch rates up to 187.3 per net night and one of the highest hydro acoustic density estimates in Wisconsin (Lyons et al. 2015; P. Kanehl, Wisconsin Department of Natural Resources, unpublished data; T. Parks, Wisconsin Department of Natural Resources, unpublished data). These ongoing cisco surveys are crucial to monitoring the most important forage fish in the system and partnering with DNR research staff to complete these surveys should be made a priority in the future.

Total **walleye** abundance was estimated at only 0.59 per acre, with females greatly outnumbering males. Relative abundance during spring netting (6.7 per net night) was in line with expectations for a lake like Geneva (A. L. Rypel, Wisconsin Department of Natural Resources, unpublished data). Size structure was very strong (PSD of 83) and nearly 81% of the walleye captured were over the 15" minimum length limit. Anderson and Weithman (1978) recommended a PSD range of 30-60 for balanced walleye populations. Geneva has a long history of maintaining a low abundance walleye population dominated by very large individuals. However, the two most recent comprehensive surveys conducted in 2009 and 2015 have found increasing representation of yearling and juvenile fish. While average female size remained static, average size of males and unknown fish dropped considerably due to a much higher proportion of 8-10" and 14-16" fish in the sample. Enhanced walleye stocking efforts by Walleyes for Tomorrow and DNR are expected to improve the likelihood of multiple successful year classes resulting in a notable increase in adult density over time.

Walleye growth rates in Geneva Lake were above other lakes in southern Wisconsin, which are typically faster than the statewide average. Most fish reached the statewide standard 15" minimum length limit before their third year. Such accelerated growth rates in the southern part of the state often leave walleye vulnerable to harvest prior to reaching sexual maturity, which typically occurs from age 3 to 5 (Becker 1983). Geneva Lake also has a documented history of natural reproduction of walleye, though at low levels in recent years. This includes six yearling walleye captured during the 2015 survey that were naturally produced in 2014. The most likely limiting factors for walleye natural reproduction in many area lakes are poor adult walleye abundance (due to relatively low stocking rates and the increased harvest vulnerability of sub-adult and adult walleye caused by accelerated growth rates), a lack of optimal walleye spawning habitat, and predation/competition from overly abundant largemouth bass populations. The most significant of these factors for Geneva Lake are walleye stocking rates and harvest pressure, whereas walleye spawning habitat is more plentiful in Geneva than in perhaps any other lake in the area.

In recent years, Geneva Lake was typically stocked with between 177,000 and 275,000 small fingerling walleye (average size 1.6"). Survival rates of small fingerling walleye are generally quite poor, particularly in systems with very clear water and/or an abundance of predators. The Walworth County Chapter of Walleyes for Tomorrow began hatching and stocking walleye fry on Geneva in 2012. The portable hatchery closed in 2016, after stocking 18.4 million fry in five years of operation. The Walleyes for Tomorrow walleye wagon deserves particular mention here, as genetic analyses indicated 60% of the yearling walleye captured during the 2015 spring netting survey originated from the walleye wagon. The Walworth County Chapter of Walleyes for Tomorrow, led by Brian Simon, successfully met the challenge of capturing young female walleye with viable eggs and stocking fry into a clear lake with a multitude of predators. The time and effort they put in to customizing their approach to increase the likelihood of success in this particular system is evident in the 2015 yearling results and likely in future surveys, as well. Large fingerling walleye stocking rates greatly increased for Geneva Lake and many other lakes throughout the state with the implementation of the Wisconsin Walleye Initiative in 2013. Geneva Lake was stocked with a total of 108,020 large fingerling walleye (average size 7.3") in 2015. Such a significant increase in stocking rates and average size of stocked fish is expected to greatly improve survival rates and the likelihood of establishing a fishable adult walleye population in the short term. Geneva Lake has extensive swaths of high quality walleye spawning habitat and a diverse and abundant forage base capable of supporting higher adult walleye abundance. High stocking rates should increase levels of natural reproduction in the system. Given the accelerated walleye growth rates in Geneva Lake, long-term sustainability of the walleye population will require increasing the minimum length limit to protect adult walleye from harvest for at least one spawning season.

Muskellunge were first introduced into Geneva Lake when 3,492 large fingerlings (average size 13.1") were stocked in 2010. Muskellunge have since been stocked in alternate years and all muskellunge were marked with differential year-specific fin removals prior to stocking to readily identify year classes during future surveys. Muskellunge relative abundance (0.4 per net night) meets expectations for A1 muskellunge waters in Wisconsin (i.e., trophy muskellunge waters with exceptional size structure) and lakes with similar fish communities and morphology as Geneva Lake (A. L. Rypel, Wisconsin Department of Natural Resources, unpublished data), though size structure ($PSD_{38/30}$ 11) indicates a developing fishery composed primarily of young adult fish. Muskellunge growth rates in Geneva Lake were extremely accelerated, with age 3 and age 5 fish outpacing statewide average growth rates by twelve inches and six inches, respectively. The largest muskellunge captured during the survey was 39.0". Muskellunge are thriving in Geneva Lake, taking advantage of an abundant forage base to establish a very fast-growing population with strong size structure. Given the accelerated growth rates of Geneva Lake muskellunge and the resultant trophy potential of the population, protecting muskellunge with a 50" minimum length limit is also a priority for the system.

Figure 19. Large fingerling muskellunge in a net pen before being stocked into Geneva Lake in 2014.

Increasing the abundance of muskellunge in Geneva Lake fulfills several management goals, including maintaining top predator pressure on bass and panfish and providing a trophy fishing opportunity for anglers. Neither of these goals are currently being met by the **northern pike** population, which appears to be suffering from low abundance and poor size structure, likely due to the presence of the tapeworm *Triaenophorus crassus*. The tapeworm infects cisco during its intermediate plerocercoid phase and northern pike during its adult phase (Amundsen and Kristoffersen 1990). A subsample of 25 cisco captured during the 2015 gill netting survey showed a 100% infestation rate of *T. crassus*. Northern pike that feed on cisco are therefore very likely to harbor the adult form of the tapeworm, potentially resulting in the below average northern pike population metrics found in recent surveys. The 2009 comprehensive survey on Geneva Lake found a northern pike catch rate of 0.7 per net night and PSD of 31, with only 1.2% of fish captured exceeding the 32" minimum length limit. These results are well below expectations for a two-story lake like Geneva Lake (A. L. Rypel, Wisconsin Department of Natural Resources, unpublished data) and lag behind recent results from Big Green Lake in Green Lake County. Northern pike under-performance is even more apparent when considering the above average growth rates of other gamefish in Geneva Lake. Loosening harvest restrictions and maximizing angler exploitation of northern pike is a priority for future management of the Geneva Lake fish community, as pike exploitation is considered the most effective means of *T. crassus* control (Amundsen and Kristoffersen 1990). Muskellunge are capable of filling the top predator void already partially vacated by northern pike and have not shown susceptibility to the pike tapeworm in other waters. Given the accelerated growth rates of Geneva muskies and the resultant trophy potential of the population, protecting muskies with a 50" minimum length limit is also a priority for the system.

Figure 20. Plerocercoid phase tapeworm in cisco filets from the 2015 Geneva Lake gill netting survey.

Largemouth bass relative abundance was moderate compared to other lakes in the area (15.3 per electrofishing mile), but very high for lakes with similar fish communities and morphology as Geneva Lake (A. L. Rypel, Wisconsin Department of Natural Resources, unpublished data). Size structure was very strong (PSD 69). Gabelhouse (1984) recommended a bass PSD range of 40-70 for a moderate density population in a balanced fish community made up of several popular species. Largemouth PSD was higher than expected based on the results of a recent statewide lake classification model (Hansen and Hansen 2016). Over 37% of the bass captured in the 2015 survey were of legal size (14" and greater), further indicating a strong size structure within the bass population. Relative abundance in the 2015 survey was equal to the 2009 survey, though size structure was stronger in 2009, primarily due to a higher number of small fish captured during the 2015 survey. Late spring electrofishing surveys on Geneva Lake are hampered by the high number of private piers on the lake, which limits access to the nearshore sampling zone and likely depresses catch rates. Geneva Lake hosts several bass fishing tournaments each year, which provide additional information to evaluate bass relative abundance. May has traditionally been the most successful month for smallmouth bass tournament catch rates, whereas largemouth bass are

caught at the highest rate in July and August. Largemouth bass are typically twice as prevalent as smallmouth bass during fishing tournaments. **Smallmouth bass** are abundant in Geneva Lake and are a highly desirable gamefish for many anglers, but were not sampled effectively during the 2015 or 2009 surveys.

Bluegill relative abundance was low (30.7 per electrofishing mile), as was size structure, with an average size of 4.7" and less than 11% of fish exceeding 6". Bluegill were not effectively sampled during the 2009 survey. **Yellow perch** relative abundance was also low (23.3 per electrofishing mile) and average size was 5.4". Yellow perch relative abundance and size structure were generally higher in the 2009 survey. Panfish relative abundance results were also likely hampered by the high number of piers present during the late spring electrofishing survey. Given the spawning behavior of yellow perch and their propensity for spawning earlier than bass and panfish, it is recommended that all perch data be collected during spring fyke netting in future surveys.

Lake trout relative abundance during the fall fyke netting survey was very good in comparison to other systems in the state (7.9 per net night). Size structure was strong, with an average size of 27.5" and all fish sampled were over the 17" minimum length limit. Lake Geneva's bathymetry and abundant cisco forage base is very conducive to lake trout success. The lake trout size structure and relative abundance in Geneva Lake are roughly equal to the popular trout fisheries in Trout Lake (Vilas County) and Big Green Lake (Green Lake County).

MANAGEMENT RECOMMENDATIONS

- Maintain and enhance the valuable cooperative relationships between DNR Fisheries Management and the various stakeholder groups, local municipalities and other cooperators to achieve common goals (stocking, monitoring, etc.).
- Northern pike
    - Goal: Maximize the exploitation of northern pike by loosening harvest restrictions to reduce pike abundance and possibly reduce the occurrence of the tapeworm *Triaenophorus crassus* in pike and cisco.
    - Objective: Reduce *T. crassus* occurrence to 25% or less in cisco examined during gill netting surveys.
- Walleye
    - Goal: Maximize stocking rates of walleye (preferably large fingerling) to improve abundance and promote increased levels of natural reproduction. Protect adult walleye for at least one spawning season with an 18" minimum length limit and daily bag of three to promote increased levels of natural reproduction and improve the likelihood of sustaining a long term, fishable walleye population.
    - Objective: Increase adult walleye abundance to 2.0 per acre and maintain PSD at 50 or greater. Young-of-year relative abundance objectives are not appropriate for Geneva Lake due to the difficulty of effectively sampling walleye during fall electrofishing surveys given the high density of piers on Geneva Lake.
- Muskellunge
    - Objective: Maximize stocking rates of muskellunge in the short term with annual large fingerling stocking to improve abundance and establish and effective top predator presence more quickly. Protect large adult muskellunge with a 50" minimum length limit to maximize their trophy potential and provide top predator pressure on small panfish and other species. The habitat and forage diversity of Geneva Lake has the potential to produce a unique trophy muskellunge fishing opportunity.

    - Goal: Increase adult muskellunge abundance to 0.25 per acre and/or muskellunge relative abundance to 0.7 per net night while increasing $PSD_{38/30}$ to 50 or greater and $PSD_{45/30}$ to 10 or greater.
- Prioritize continued monitoring of cisco relative abundance and size structure in partnership with DNR Science Services staff.
- Continue to monitor lake trout relative abundance and size structure every 6-8 years and possibly assess the contribution of stocking vs. natural reproduction as funding allows.
- Continue to monitor bass and panfish relative abundance and/or size structure every 6-8 years as changes occur among other gamefish species.

ACKNOWLEDGMENTS

Geneva Lake is home to a wide variety of dedicated stakeholder groups including (but not limited to) Abbey Springs Marina, Geneva Lake Environmental Agency, Kishwauketoe Nature Conservancy, Lake Geneva Fishing Club, Musky Clubs Alliance of Wisconsin, the Village of Williams Bay, Walleyes Unlimited, and Walworth County Chapter of Walleyes for Tomorrow. These groups have contributed volunteer labor, funding, water quality monitoring or fish stocking, directly assisting with the effective management of the Geneva Lake fish community. The collaborative relationships between DNR Fisheries Management and these groups is extremely valuable and should be fostered into the future.

RECENT STOCKING HISTORY

Year	Species	Size	Number
2016	Lake Trout	Large fingerling (4.6”)	41,306
	Brown Trout	Large fingerling (5.5”)	24,997
	Muskellunge	Large fingerling (10.9”)	2,245
	Walleye (WFT)	Fry	4,130,000
2015	Lake Trout	Large fingerling (5.0”)	36,446
	Brown Trout	Large fingerling (5.2”)	22,203
	Walleye	Large fingerling (7.3”)	108,020
	Walleye (WFT)	Fry	3,780,000
2014	Lake Trout	Large fingerling (4.7”)	39,581
	Muskellunge	Large fingerling (11.3”)	2,499
	Brown Trout	Large fingerling (5.0”)	28,671
	Walleye (WFT)	Fry	4,784,962
2013	Lake Trout	Large fingerling (4.6”)	32,560
	Brown Trout	Large fingerling (5.1”)	25,239
	Walleye	Small fingerling (1.5”)	184,555
	Walleye (WFT)	Fry	6,198,038
2012	Brown Trout	Large fingerling (5.1”)	24,995
	Lake Trout	Large fingerling (4.3”)	31,035
	Muskellunge	Large fingerling (11.5”)	2,490
	Walleye (WFT)	Fry	1,826,000
2011	Lake Trout	Large fingerling (4.2”)	21,458
	Brown Trout	Large fingerling (5.2”)	27,000
	Walleye	Small fingerling (1.4”)	177,651
2010	Muskellunge	Large fingerling (13.1”)	3,492
	Brown Trout	Large fingerling (5.7”)	17,608

	Walleye	Small fingerling (1.5”)	188,966
2009	Lake Trout	Large fingerling (5.0”)	55,205
	Brown Trout	Large fingerling (5.1”)	26,541
2008	Brown Trout	Large fingerling (5.7”)	28,000
2007	Brown Trout	Large fingerling (5.9”)	26,310
2006	Lake Trout	Large fingerling (4.6”)	26,749
	Brown Trout	Large fingerling (5.6”)	12,000
2005	Lake Trout	Large fingerling (4.7”)	31,122
	Brown Trout	Large fingerling (4.0”)	12,000
	Walleye	Small fingerling (1.4”)	238,132
	Brown Trout	Yearling (7.2”)	4,412
2004	Lake Trout	Large fingerling (5.1”)	25.913
	Brown Trout	Large fingerling (4.5”)	12,000
	Lake Trout	Small fingerling (2.0”)	50,500
2003	Lake Trout	Large fingerling (5.3”)	22,949
	Brown Trout	Large fingerling (4.9”)	12,000
	Walleye	Small fingerling (2.1”)	247,369
2002	Lake Trout	Large fingerling (5.4”)	18,084
	Brown Trout	Large fingerling (3.9”)	14,302
2001	Lake Trout	Large fingerling	20,000
	Brown Trout	Large fingerling (4.9”)	16,000
	Walleye	Large fingerling (1.4”)	275,415
2000	Lake Trout	Large fingerling (5.8”)	12,000
	Brown Trout	Large fingerling	3,000

LITERATURE CITED

Amundsen, P, and R. Kristoffersen. 1990. Infection of whitefish (*Coregonus lavaretus* L. s.l.) by *Triaenophorus crassus* Forel (Cestoda: Pseudophyllidea): a case study in parasite control. Canadian Journal of Zoology 68:1187-1192.

Anderson, R. O. 1985. Managing ponds for good fishing. University of Missouri-Columbia Extension Division.

Anderson, R. O., and A. S. Weithman. 1978. The concept of balance for coolwater fish populations. American Fisheries Society Special Publication 11:371-381.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison, Wisconsin.

Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:3 273-285.

Hansen, G., and J. Hansen. 2016. A proposed lakes classification system for black bass. Wisconsin Department of Natural Resources internal report.

Lyons, J., J. Kampa, T. Parks, and G. Sass. 2015. The whitefishes of Wisconsin’s inland lakes: the 2011-2014 Wisconsin Department of Natural Resources cisco and lake whitefish survey. Fisheries and Aquatic Research Section, Wisconsin Department of Natural Resources.